THE TOLLY GROUP

No. 204103 January 2004

Dell Inc.

PowerConnect 6024

Tolly Verified Layer 2/Layer 3 Gigabit Ethernet Throughput Testing and Functionality Evaluation

Test Summary

Premise: *Layer 2/Layer 3 switches used as network aggregation points must possess wire-speed performance to handle a variety of 'real-world' traffic scenarios, offer a secure platform, deliver hardware/software redundancy to ensure uptime, and possess the capability to support real-time and non-real-time traffic to be a truly effective junction point for aggregating traffic and passing it into the network core.*

Dell Inc. commissioned The Tolly Group to evaluate its PowerConnect 6024, a 24-port Gigabit Ethernet switch designed for use as an enterprise-class aggregation or data center switch. The PowerConnect 6024 is a fixed-port Layer 3 model that comes configured with hot-swappable power supplies and fans, support for the Virtual Router Redundancy Protocol and other high availability features that make it suitable as an aggregation switch or a core device for small to medium enterprises. Static routes, OSPF, RIP, DVMRP are also supported in the PowerConnect 6024 series.

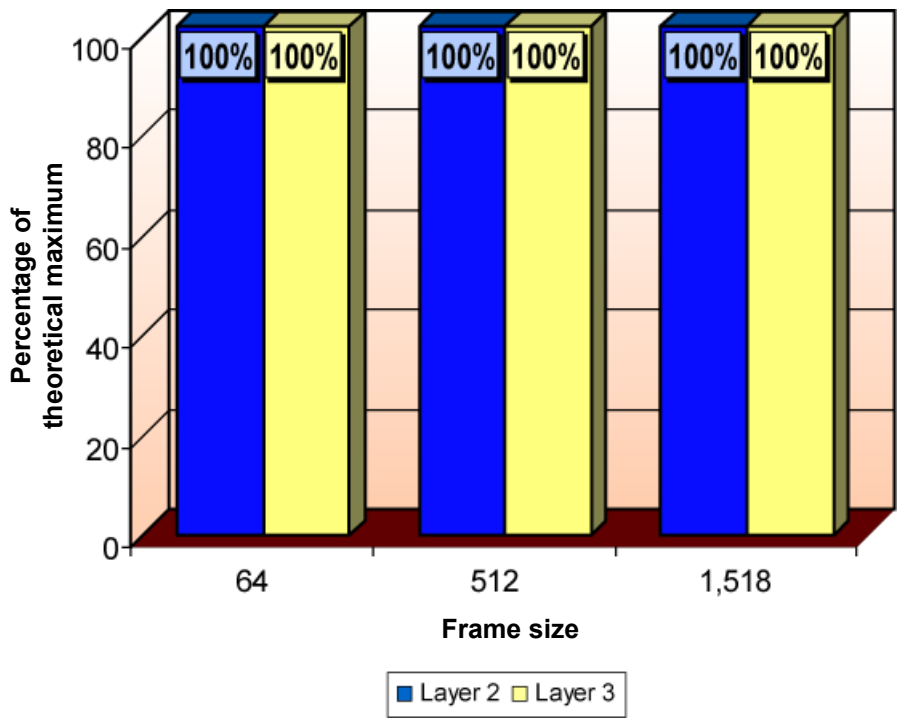
The Tolly Group tested the Layer 2/Layer 3 throughput of the PowerConnect 6024 while it was subjected to standard fixed packet sizes, as well as to a real-world test scenario with variable-size packets and access control lists enabled. Tests were conducted in December 2003 at The Tolly Group's Boca Raton, FL., test facilities.

Tests show that the PowerConnect 6024 delivers GbE wire-speed throughput at both Layer 2 and Layer 3. Throughput tests were conducted with variable frame sizes and with access control lists (ACLs) enabled to verify throughput even under stressful conditions. Tolly Group engineers also validated more than a dozen key switch functions under The Tolly Group's Tolly Verified certification program.

Test Highlights

- Delivers wire-speed Layer 2/Layer 3 performance
- Offers a secure aggregation switch supporting port and IP access authentication, ACLs and RADIUS
- Provides robust hardware and software redundancy features, including support for VRRP
- Supports high-quality voice transport making it an excellent platform to aggregate network traffic

Layer 2/Layer 3 Gigabit Ethernet Throughput
Across 24 GbE Ports in a Full-Mesh Design



Source: The Tolly Group, January 2004

Figure 1

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Results

Layer 2/3 Wire-Speed Gigabit Ethernet Throughput All Ports, Tolly Verified 10553/10554

This certification set verifies the backplane capacity of the switch. Specifically, that it can deliver wire-speed throughput for a standard set of frame sizes including the minimum and maximum allowable frame sizes with all ports active. Tolly Group engineers measured the Layer 2 and Layer 3 throughput of the PowerConnect 6024 using standard frame sizes ranging from 64 bytes to 1,518 bytes.

In the Layer 2 and Layer 3 throughput tests administered, the PowerConnect 6024 delivered wire-speed throughput, or 100% of the theoretical maximum throughput when tested with 64-, 512- and 1,518-byte frames. (See Figure 1.)

In addition to the standard Tolly Verified tests, engineers also tested device throughput with access control lists (ACLs) enabled, meaning the switch incurred the extra overhead of processing ACL lists while handling a steady stream of variable frame traffic. Here, the PowerConnect 6024 delivered an average throughput equal to 94% of the theoretical maximum throughput when tested across six different frame sizes ranging from 64 bytes to 1,518 bytes.

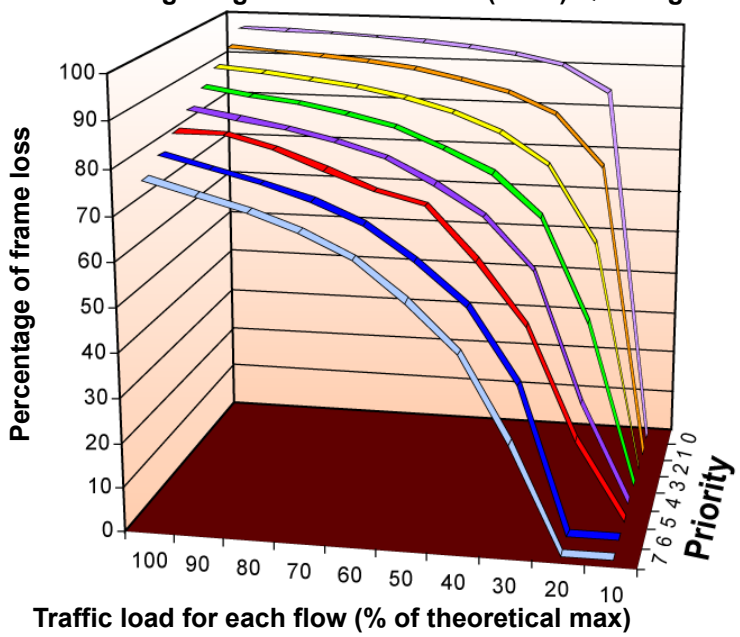
QoS Recognition (IEEE 802.1p) Tolly Verified 10533

The PowerConnect 6024 passed this certification that verifies a device's ability to distinguish and prioritize traffic based on the 802.1p Quality of Service standards. For verification purposes a given device must be able to differentiate between two streams that are "tagged" using this standard. Traffic is forwarded exercising both queues. During over subscription traffic tagged as "high" should receive preferential treatment (i.e. more bandwidth).

QoS – Eight Traffic Queues Tolly Verified 10587

The PowerConnect 6024 earned this certification that uses a complex stream to

Frame-Loss Rate for Prioritized Traffic Flows
Using Weighted Round Robin (WRR) Queuing



Source: The Tolly Group, January 2004 *Figure 2*

Tolly Verified Certifications Earned

Certification ID	Certification	Category
10501	Voice Quality Benchmark Across LAN Switch	LAN Switch Core
10513	10/100/1000 Auto-Negotiation	LAN Connectivity
10514	Auto MDI/MDIX	LAN Switch Core
10529	Access Control List (ACL) Functionality Bound to Specified VLAN	LAN Switch Core
10532	VLAN Feature Verification (802.1Q)	LAN Switch Core
10533	Quality-of-Service Feature Verification	LAN Switch Core
10535	Management Access and Authorization via IP Access List	System Security and User Management
10536	Management Access and Authorization via RADIUS Server	System Security and User Management
10537	Access Control List (ACL) Functionality Bound to MAC Address	LAN Switch Core
10553	IPv4 (L3) Wire-Speed Gigabit Ethernet - All Ports (Fixed Configuration Switch)	LAN Switch Core
10554	Layer 2 Wire-Speed Gigabit Ethernet - All Ports (Fixed Configuration Switch)	LAN Switch Core
10564	Virtual Router Redundancy Protocol (VRRP)	LAN Switch Core
10583	Access Control List Functionality Bound to Specified Layer 3 Information (IP Address)	LAN Switch Core
10584	Access Control List Functionality Bound to Specified Layer 4 Information (TCP/UDP Port Number)	LAN Switch Core
10587	Eight Queue QoS Test	LAN Switch Core
10594	Redundant Power Supply – Hot Swappable	High-Availability Core
10595	Hot-Swappable Fan	High-Availability Core

For detailed descriptions of any of these certifications, visit www.tolly.com

Source: The Tolly Group, January 2004 *Figure 3*

verify the actual number of internal processing queues in the switch. (*Note: many switches accept traffic tagged with any of eight priorities but have fewer internal queues thus forcing multiple tagged priorities to be mapped into the same internal queue.*) In the verification of the PowerConnect 6024, Tolly Group engineers observed the switch handling traffic over eight prioritized queues, apportioning bandwidth according to priority policy and a weighted round robin queuing algorithm. (*Note: the specific priority queuing method used is not specified by the TV certification.*) (See Figure 2.)

VoIP Capable Infrastructure (QoS), Tolly Verified 10501

This certification verifies that the device under test's QoS mechanisms can adequately support latency sensitive applications such as voice in a congested environment by providing sufficiently low latency as well as voice quality scores that are coincident with those deemed toll quality.

Engineers measured the baseline voice quality and one-way delay using an Agilent Voice Quality Tester connected to VoIP phone handsets and communicating across the device under test with no other traffic present. With QoS on the DUT disabled, the engineers re-ran the baseline while simultaneously generating line-rate traffic destined for the same output port. Engineers verified that voice quality suffers and/or the call is dropped.

Tests using the Perceptual Evaluation of Speech Quality (PESQ) metric indicate a baseline voice call quality of 3.99 (any score greater than 3.8 is considered toll quality). With no QoS active and congestion taxing the switch the score dropped to 1.79 but bounced right back to 4.01 once QoS was activated.

VRRP, Tolly Verified 10564

This certification verifies the device under test implements the VRRP backup router function. Devices earning this certification have illustrated that the device can detect the failure of a primary router automatically and take over the role of "master." Such devices can help remove the router as a single-point of failure and increase the reliability and availability of your network.

ACL Functionality Bound to Layer 3 info, Tolly Verified 10583

This certification verifies that the tested device can permit or deny traffic based on the Layer 3 (IP) address of traffic traversing the switch.

ACL Functionality Bound to Layer 4 info, Tolly Verified 10584

This cert verifies that the tested device can permit or deny traffic based on the Layer 4 (TCP/UDP) port of traffic traversing the switch.

Port Access Authorization via MAC Address, Tolly Verified 10537

This certification verifies that the device under test provides functionality that allows network managers to limit client port access to stations that have specific Layer 2 MAC addresses.

Management Access Authentication via IP Access Control Lists, Tolly Verified 10535

This certification verifies that the device under test provides functionality that allows network mangers to limit management access to the switch to host computers that use specific TCP/IP addresses.

Management Access Authentication via RADIUS, Tolly Verified 10536

This certification verifies that the device under test provides functionality that allows network mangers to limit management access to users that complete authentication with a backend RADIUS server with which the device under test communicates.

Dell Inc.

PowerConnect 6024

'Tolly Verified' Layer 2/3 Performance & Functionality

Dell Inc.
PowerConnect 6024
Product Specifications*

Ports

- 24 10/100/1000BASE-T auto-sensing Gigabit Ethernet switching ports
- Eight SFP combo slots for fiber media support (Note: SFP slots are used instead of the built-in 10/100/1000BaseT ports)

Performance

- Switch fabric capacity 48 Gbps
- Forwarding Rate 35.6 Mpps
- Up to 14,000 MAC addresses
- Supports 12,000 unicast routes, 8,000 multicast routes
- 64 Mbytes of packet buffer memory
- 256 Mbytes of CPU SDRAM
- 32 Mbytes of flash memory
- Auto-negotiation for speed, duplex mode and flow control
- Auto MDI/MDIX
- Port mirroring (many to one)
- Broadcast storm control

Availability

- Dual internal redundant hot-swap power supplies
- Dual internal redundant hot-swap cooling fans
- Integrated cable tester
- Supports Virtual Redundant Routing Protocol (VRRP)
- Spanning Tree (IEEE 802.1D)
- Rapid Spanning Tree (IEEE 802.1w), with Fast Link Support

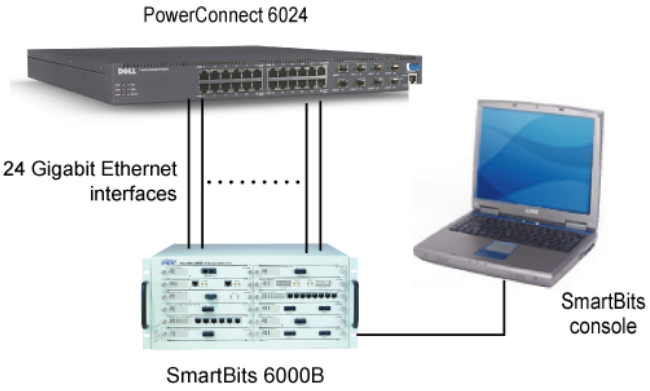
Layer 3 Routing Protocols

- Static routes
- RIP v1/v2, OSPF v1/v2, CIDR, IRDP, ICMP, VRRP, ARP, IGMP v2, DVMRP, DHCP

For more information contact:
Dell Inc.
One Dell Way
Round Rock, Texas 78682
(800) Buy-Dell [289-3355]
URL: http://www.dell.com/networking

**Vendor-supplied information not verified by The Tolly Group*

Layer 2/Layer 3 Throughput Test Bed
VLAN Feature Verification/Eight Queue QoS Test



Source: The Tolly Group, October 2003 *Figure 4*

Test Configuration and Methodology

For performance tests, The Tolly Group tested a Dell Inc. PowerConnect 6024, hardware version 0.1.64 running software version SW 1.0.2.27. The PowerConnect 6024 was configured with 24 Gigabit Ethernet ports, consisting of 16 copper interfaces and eight combination copper/fiber interfaces.

For Layer 2 testing, engineers configured a test bed in which all 24 Gigabit Ethernet ports were destined for each other in a full-mesh configuration. For bidirectional steady state, zero-loss (≤ 0.001%) throughput tests of 64-, 512 and 1,518-byte frames, engineers used SmartBits to generate Layer 2 traffic in the configuration described above with an initial load of 100%.

For Layer 3 testing, the same methodology was used. The only difference was that engineers configured the switch in such way that all 24 Gigabit Ethernet interfaces were in different IP subnet groups, which means that each interface was in a different VLAN group. By doing so, routing occurred when the traffic traversed between interfaces.

The Tolly Group gratefully acknowledges the providers of test equipment used in this project.

Vendor	Product	Web address
Agilent Technologies	Voice Quality Tester	http://www.agilent.com
Ethereal	Ethereal 0.9.16	http://www.ethereal.com
Spirent Communications	SmartBits 6000B	http://www.spirent.com
Spirent Communications	SmartFlow Ver 3.00	http://www.spirent.com
Spirent Communications	SmartWindows Ver 7.70	http://www.spirent.com

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TOLLY FAIR TESTING CHARTER

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Project Profile

Sponsor: Dell Inc.
Document number: 204103
Product class: Gigabit Ethernet Switch
Products under test:

- PowerConnect 6024 HW Version 0.1.64

Testing window: December 2003
Software versions tested:

- SW 1.0.2.27

Software status: Generally available

For more information on this document, or other services offered by The Tolly Group, visit our World Wide Web site at http://www.tolly.com, send E-mail to sales@tolly.com, call (561) 391-5610.

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